Mapping and Geoprocessing Tools in Support of Rural Advisory Systems

Virtual Globes, Global Positioning System, and Geographic Information Systems: Simple Applications, Case Studies, and Guidelines

Ernst Gabathuler, Sandra Eckert, Albrecht Ehrensperger, Felicitas Bachmann

b
UNIVERSITÄT
BERN

CDE
CENTRE FOR DEVELOPMENT
AND ENVIRONMENT

Mapping and Geoprocessing Tools in Support of Rural Advisory Systems

Virtual Globes, Global Positioning System, and Geographic Information Systems: Simple Applications, Case Studies, and Guidelines

Ernst Gabathuler, Sandra Eckert, Albrecht Ehrensperger, Felicitas Bachmann

2012

MARGRAF PUBLISHERS

Ernst Gabathuler, Sandra Eckert, Albrecht Ehrensperger, Felicitas Bachmann
Centre for Development and Environment (CDE), University of Bern, Switzerland

Mapping and Geoprocessing Tools in Support of Rural Advisory Systems
Virtual Globes, Global Positioning System, and Geographic Information Systems: Simple Applications, Case Studies, and Guidelines

Bibliographic information published by „Die Deutsche Nationalbibliothek"
Die Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the Internet at http://dnb.ddb.de.

Layout: Simone Kummer, CDE

Language editing: Marlène Thibault, CDE

Printing: TZ-Verlag & Print GmbH, Rossdorf, Germany

Cover photo: Albrecht Ehrensperger

© Margraf Publishers GmbH, 2012
Kanalstr. 21, P.O. Box 1205
D-97990 Weikersheim
www.margraf-publishers.eu

ISBN 978-3-8236-1640-5

MARGRAF PUBLISHERS

Content

Acknowledgements 6
Abbreviations 7
Summary 9

Part 1: Introduction and background 11
1.1 The use of mapping tools in rural extension and development 13
1.1.1 Rationale 13
1.1.2 A multitude of technologies 14
1.1.3 Challenges 15

1.2 The use of mapping tools in the context of a learning-oriented extension approach 16
1.2.1 The Learning for Sustainability (LforS) extension approach 17
1.2.2 Applying geoprocessing tools in the LforS fields of activity 18
1.2.3 Rural extension as a key component of rural development 20

Part 2: Illustration 21
2.1 Applying geoprocessing tools: practical examples and case studies 23
2.1.1 Google Earth: an easy-to-use mapping tool for rural extension 23
Example 1: Mapping baseline information 24
Example 2: Negotiating and planning concrete measures for implementation 26
Example 3: Comparing satellite images from different years 28
Example 4: Defining land use zones and negotiating land use rules 30
Example 5: Observing the status and development of natural resources along a transect route 32
Example 6: Developing an irrigation water management plan and irrigation schedules 34
Example 7: Mapping impacts of extension activities 36
Example 8: Monitoring socio-economic indicators 38
2.1.2 GIS and GPS: using geoprocessing tools in broader rural development contexts 40

Case studies 41
1. Assessing jatropha hedges for local energy supply (Madagascar) 42
2. Participatory planning of pasture use (Kyrgyzstan) 46
3. Ogiek peoples ancestral territories atlas (Kenya) 50
4. Mapping water use conflict hotspots (Kenya) 54
5. Water information platform (Kenya) 58
6. Surface water assessment (Eritrea) 62
7. Human–elephant conflict mitigation (Kenya) 66
8. Local urban observatory (Kenya) 70
9. Mapping community forests (Nepal) 74
10. Forest monitoring and assessment of carbon (Madagascar) 78

Part 3: Practical instructions 83

3.1 Introduction 85

3.1.1 Objectives of these instructions 85
3.1.2 Links to detailed handbooks, tutorials, and user forums 85
3.1.3 Selection of tools presented 86

3.2 Spatial data 87

3.2.1 Data models 88
3.2.2 File formats 90
3.2.3 Data scale and quality 91
3.2.4 Spatial reference systems 91
3.2.5 Geo-reference 93
3.2.6 Open-access data sources 93
3.2.7 Generating own spatial data 95
3.2.8 Spatial data management 97

3.3 GPS 99

3.3.1 Choosing the right GPS receiver 99
3.3.2 Preparing for fieldwork 100
3.3.3 Recording GPS data in the field 100
3.3.4 Downloading GPS data 101

3.4 Google Earth 102

3.4.1 Introduction to Google Earth 102

3.4.1.1 Description of functionalities 102
3.4.1.2 The difference between Google Earth and Google Earth Pro 102
3.4.1.3 Installing and using Google Earth 103
3.4.1.4 The Google Earth graphic user interface 103
3.4.1.5 Google Earth compatible file formats 104

3.4.2 Creating and editing data in Google Earth 105

3.4.2.1 Downloading and importing GPS data directly into Google Earth 105
3.4.2.2 Creating points, paths, and polygons 105
3.4.2.3 Modifying, editing, and deleting features 106
3.4.2.4 Simple vector analysis of Google Earth KML files 106
3.4.2.5 Image overlay: importing maps and historical satellite data 107
3.4.2.6 Combining information from different maps 108

3.5 Quantum GIS 108

3.5.1 Introduction to Quantum GIS 108

3.5.2 Creating spatial data in Quantum GIS 109

3.5.2.1 Downloading and importing GPS data into Quantum GIS 109
3.5.2.2 Importing tabular data into Quantum GIS 109
3.5.2.3 Defining a projection and reprojecting spatial data 110
3.5.2.4 Digitising and editing data in Quantum GIS 112
3.5.2.5 Scanning and geo-referencing paper maps in Quantum GIS 112

3.5.3 Creating maps in Quantum GIS 113

3.5.3.1 Important mapping rules 113
3.5.3.2 Creating a map in Quantum GIS 114

3.5.4 Simple vector analysis and spatial queries in Quantum GIS 116

3.5.4.1 Introduction to vector analysis 116
3.5.4.2 Vector analysis in Quantum GIS: fTools 116

3.5.5 Simple raster analysis in QGIS 119

3.5.5.1 Introduction to raster analysis 119
3.5.5.2 Raster calculation in Quantum GIS 120
3.5.5.3 Raster analysis in Quantum GIS: GdalTools 120
3.5.5.4 Interpolation: how to create a digital elevation model (DEM) from digitised contour lines 121
3.5.5.5 How to generate a slope raster layer from the digital elevation layer 121

References 123

Acknowledgements

The compilation and publication of this book would not have been possible without the support of a number of colleagues within and outside CDE. Our thanks go to Thomas Kohler, Hans Hurni, Urs Wiesmann, and Markus Giger for their inputs at the conceptual stage of this publication. Special thanks go to Markus Giger for keeping us going, Gudrun Schwilch for her valuable feedback on a previous draft of the publication, Karl Herweg for letting us benefit from his artistic talent, and Jürg Krauer for his valuable hints regarding all kind of GIS issues. We are especially grateful to all contributors and contact persons of the case studies for sharing their original project descriptions, data sets, photos, and valuable feedback. We thank Marlène Thibault for editing and harmonising the texts written by different authors, Simone Kummer for making the publication look attractive, and both of them for their enduring patience and flexibility. Our thanks also go to Stephan Zach for proofreading the manuscript.

We gratefully acknowledge financial support from the Swiss Agency for Development and Cooperation (SDC), the Eastern and Southern Africa Partnership Programme (ESAPP), and the Centre for Development and Environment (CDE). It has made the production and publication of this book possible.

We made all reasonable efforts to obtain permissions for reproducing figures. We acknowledge the permissions granted by Pearson Education in Harlow, UK, and the Alfred Wegener Institute in Bremerhaven, Germany.

Abbreviations

BIA	Bioenergy in Africa (project)
CDE	Centre for Development and Environment, University of Bern, Switzerland
CETRAD	Centre for Training and Integrated Research in Arid and Semi-arid Lands (ASAL) Development, Nanyuki, Kenya
CRS	Coordinate Reference System
DEM	Digital Elevation Model
DERAD	Diagnostic Environnemental et Recherches Appliquées pour le Développement en milieu rural, Madagascar
ENNDA	Ewaso Ng'iro North Development Authority, Kenya
ERA-ARD	The Agricultural Research for Development (ARD) Dimension of the European Research Area (ERA)
ERMIS Africa	Environmental Research Mapping and Information Systems in Africa
ESAPP	Eastern and Southern Africa Partnership Programme
ESRI	Environmental Systems Research Institute
ESSA Forêts	École Supérieure des Sciences Agronomiques, Département des Eaux et Forêts, Université d'Antananarivo, Madagascar
FAO	Food and Agriculture Organisation of the United Nations
GIS	Geographic information system
GIT	Geographic information technologies
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPS	Global Positioning System
GRS	Geographic Reference System
IIED	International Institute for Environment and Development
ITDG	Intermediate Technology Development Group
LforS	Learning for Sustainability (extension approach)
MoA	Ministry of Agriculture
NASA	National Aeronautics and Space Administration
NGO	Non-governmental organisation
NSCFP	Nepal Swiss Community Forestry Project
PGIS	Participatory GIS
PLA	Participatory Learning and Action
PRA	Participatory Rural Appraisal
QGIS	Quantum GIS (software)
RS	Remote Sensing
SDC	Swiss Agency for Development and Cooperation
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlement Programme
UTM	Universal Transverse Mercator
WGS	World Geodetic System
WHO	World Health Organisation
2D map / 3D map	Two-dimensional map / three-dimensional map

Summary

The main objective of this book is to demonstrate the potential that geoprocessing tools have for supporting rural extension and development. The focus is on the Global Positioning System (GPS), virtual globes, and simple geographic information systems (GIS). Remote sensing – the analysis and manipulation of satellite images – is not included, owing to its complexity. Based on examples, and without any claim to comprehensiveness, the book offers a range of insights into the use of these geoprocessing tools in interventions in the context of international development cooperation. The aim is to encourage extensionists and rural advisors who work with communities and have little or no experience with mapping tools to start using them whenever this makes sense and adds value to their initiatives and projects. Rural advisors with stronger technical skills in GIS and mapping will find inspiring examples of projects that have successfully made use of these tools – examples they might want to "translate" to suit their own project objectives and environments.

Background: Part 1 of the book provides background information on the role and the potential of spatial information at various stages of rural extension and development projects, on the tools available for creating, managing, analysing, and visualising spatial information, and on the specific challenges that arise when using GIS and mapping tools in rural development and extension. Part 1 also introduces the *Learning for Sustainability (LforS)* rural extension approach, which was developed by the Centre for Development and Environment (CDE) of the University of Bern, and points out how mapping tools can facilitate joint learning processes in the different fields of activity of this learning-oriented approach, thereby enhancing the work of extension services.

Illustration: Part 2 of the book illustrates the use of geoprocessing tools. First, it outlines eight possible applications of mapping tools in several *LforS* fields of activity: stakeholder dialogue, awareness raising, capacity building, and monitoring and evaluation. Second, it compiles 10 more comprehensive case studies from projects implemented by CDE and its partners in Africa, Asia, and Central Asia. The case studies serve two purposes. On the one hand, they are intended as inspiring examples of how geoprocessing tools can be applied in extension and rural development projects; on the other hand, they also offer methodological and technical information and illustrate the various steps needed to apply the tools in the given project. The presentation of case studies follows a standardised template, summarising key information on the relevant project's background and objectives, the role of GIS and mapping tools in the project, and the various steps needed to implement these tools. In addition, a technical profile provides information on the equipment and data required, the technical complexity of GIS and mapping components, and other challenges faced during project implementation.

Technical guide: Part 3 contains practical instructions for the use of handheld GPS receivers, virtual globes (*Google Earth*), and geographic information systems (*Quantum GIS*). Applications covered include GPS data collection and downloading, GIS data generation and editing, as well as simple map making and data analysis. Overall hints regarding the use of *Google Earth* are provided as well. Finally, recommendations are given on the selection of adequate technical tools, as well as on how to access, generate, and manage spatial data in the context of rural extension and development. The technical guidance provided is of an introductory nature; readers who are interested in further developing their technical skills will find useful links to freely available sources, forums, and tutorials.

Rural extension and development processes are complex and require many different skills. They usually extend over long periods and are driven or influenced by various groups of stakeholders in varying compositions. The information and instructions provided in this book focus on those stages in such processes during which the use of technical mapping and spatial analysis tools helps to enhance the entire process. The tools presented should be understood as complementary to other tools and approaches used in rural extension and development.